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ON THE INTENSITY OF IMAGES[1]

By ALMA DE VRIES SCHAUB

CONTENTS

INTRODUCTION

Until recent years the experimental investigation of images has been comparatively neglected, and even at the present time the subject does not seem to receive either the extended or the detailed study that is given to sensation. Thus, while there have been studies of the general nature of mental imagery, of the memory image, and of the image of imagination, these have treated the subject mostly from the point of view of recognition and recall, and a specific investigation of the attributes of the image has been neglected. Especially meagre in the existing experimental work on imagery is reference to its intensive aspect, a subject that has played an important rôle in the study of sensation. Our aim in the present investigation has, therefore, been to attack the problem of images from the point of view of their intensity. More specifically, we seek to answer two questions: (1) Do images possess the attribute of intensity? and, if so, (2) Is this intensity comparable with that of sensations, and in how far? A brief review of the mention of this subject in psychological literature and in experimental investigation will serve not only to introduce the problem but also to show the urgent need for its careful examination.

[1]From the Psychological Laboratory of Cornell University

(a) *Historical*

Though almost all writers agree in accepting intensity as one of the attributes of sensation, there is by no means such agreement with regard to the intensity of images. Indeed, many of the earlier writers, and a few of the more recent as well, seem to find in intensity the main difference between images and sensations. They have either denied this attribute altogether to certain images, or, at best, have granted them but a small measure of it. The clearest and most concise expression of this view, perhaps, is that of Hume. "All the perceptions of the human mind," he tells us, "resolve themselves into two distinct kinds which I shall call Impressions and Ideas. The difference betwixt these consists in the degree of force and liveliness with which they strike upon the mind. . . . , Those perceptions which enter with most force and violence we may name *impressions;* . . . By *ideas* I mean the faint images of these in thinking and reasoning."[1] That Hume regards difference in intensity as the distinguishing mark of the image, appears also in such statements as the following: "The first circumstance that strikes my eye, is the great resemblance betwixt our impressions and ideas, in every other particular except their degree of force and vivacity."[2] "That idea of red, which we form in the dark, and that impression, which strikes our eyes in the sunshine, differ only in degree not in nature."[3] While Bain is not so explicit in regarding intensity rather than quality as the essential difference between image and sensation, he, nevertheless, calls it the most obvious point of difference.[4] Hobbes[5], John Stuart Mill[6], and Hamilton[7], barely touch upon the subject, yet indicate their assent to this view. Spencer undoubtedly confuses intensity with clearness or vividness, but on close examination his doctrine appears to agree with that of Bain. He divides feelings into "those primary and vivid feelings produced by direct excitation, and those secondary or faint feelings produced by indirect excitations," adding that he wishes to emphasize "not difference in kind, but difference in degree."[8]

Of the German writers, Lotze seems to deny absolutely that images possess the attribute of intensity. There has been some discussion with regard to his statement that "the idea of the brightest radiance does not shine, that of the intensest noise does not sound, that of the greatest torture produces no pain."[9] Such a statement, in the opinion of Titchener, reflects a form of the stimulus error.[10] Another statement of Lotze's which must be regarded as doubtful and which, by the way, is not consistent with the sentence quoted above, is the following: "Only sensations of moderate intensity allow of a reproduction that is in some measure faithful."[11] Ebbinghaus, while not actually denying intensity to images, grants them only a scant allowance. In one passage, indeed, he says: "The imaged sun does not shine and its imaged heat with its thousandfold degrees gives no warmth; the last spark of a flickering match is far more effective in both respects."[12]

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[1] David Hume: *A Treatise of Human Nature*, ed. by L. A. Selby-Bigge, 1889, 1.
[2] *Op. cit.*, 2.
[3] *Op. cit.*, 3.
[4] J. Mill: *Analysis of the Phenomena of the Human Mind*, 1878, I., 63 note; A. Bain: *The Senses and the Intellect*, 1888, 338.
[5] T. Hobbes: *Leviathan*, 1881, 6.
[6] J. Mill: *Op. cit.*, 68; note by J. S. Mill.
[7] Sir W. Hamilton: *Lectures on Metaphysics*, 1859, II., Lect. XXIII., 259 ff.
[8] H. Spencer: *The Principles of Psychology*, 1890, I., 288.
[9] H. Lotze: *Outlines of Psychology, tr.*, 1886, 28; *cf.* also *Medicinische Psychologie*, 1852 477 ff.; *Microcosmus*, i, 203 f.
[10] E. B. Titchener: *A Text-Book of Psychology*, 1910, II., 398 note.
[11] "Nur Eindruecke von mittlerer Groesse scheinen sich einigermassen entsprechend reproducieren zu lassen." *Medicinische Psychologie*, 1852, 479.
[12] "Die vorgestellte Sonne leuchtet nicht und die vorgestellte Glut ihrer Tausende von Waermegraden waermt nicht; das letzte Fuenkchen eines verglimmerenden Streichhoelzchens leistet in beiden Beziehungen weit mehr." H. Ebbinghaus: *Grundzuege der Psychologie*, I., 1905, 549.

Statements as strong as this inevitably raise doubts; it seems at least possible that there should be many to whom the memory of the burning heat of the summer sun would convey more warmth than the dying glimmer of a match. We must not neglect, however, to notice those passages in which Ebbinghaus admits that, in certain cases, images may have a measure of intensity. He tells us that there are circumstances under which the intensity of an image may be increased so as to be comparable to that of the weakest sensation.[1]

Turning from the German psychologists, we find that Paulhan speaks of the image as the feeble reproducton of a perception,[2] and Rabier states plainly that the difference between sensation and image is one of degree and not of nature.[3] Sully tells us that "the most obvious point of difference is the greater intensity of the sensational or presentative element in the percept which gives the whole structure its peculiar vividness (or strength)."[4] Baldwin summarizes the general positions held on the subject as follows: "On the one hand it is maintained that there is a specific difference between presentations and their revived images; a difference of nature. . . . Others hold that between primary and secondary states, there is only a difference of degree."[5] He proceeds to take his stand with the latter group, holding that presentations and representations have the same antecedents and effects, and "we are aware in consciousness of no peculiar marks of revived states by which to distinguish them from percepts except that they are prevailingly of less intensity."[6] So far, then, there is agreement that certain images either lack intensity except in the case of hallucinations (which are regarded as abnormal phenomena), or at least have but a small degree of intensity. The difference between images and sensations is regarded as one of intensity or strength, not of nature or quality.

Opposed to the above position are a number of prominent psychologists who regard nature or texture as the more important *differentia* of images, emphasizing the fact that these are incomplete, indistinct, fleeting. They admit that images are ordinarily less intense than sensations, but maintain that this is not universally the case. Images, for these writers, have a marked degree of intensity; indeed, they may be just as intense as sensations. Of those who uphold this view it is sufficient to mention Wundt, Kuelpe, Hoeffding, Taine, James, and Ladd. Wundt insists that while images and sense perceptions usually differ in intensity, it is the difference in elementary composition that is all-important.[7] Kuelpe goes into the matter at greater length. While admitting that images are usually of lesser intensity, duration, and extension than perceptions, he nevertheless insists that "centrally excited sensations, like peripherally excited, must be accredited with quality, intensity, and a temporal and spatial character."[8] In temporal and spatial determination and in their results, centrally and peripherally excited sensations, we are told, differ widely. The position of Hoeffding with regard to the subject is clear. He says: "There is, indeed, as a rule a difference in the degree of strength of a memory-image and a percept; but this difference may be very small, and may even quite disappear."[9] Taine seems to confuse intensity with clearness, but may nevertheless be classed with this group. "We may confidently assert, then," he says, "that the internal event which we call a sensation . . . is reproduced in us without impression from without—in the majority of cases partially, feebly, and vaguely, but in many cases with greater clearness and force."[10]

[1] See *op. cit.*, 552.
[2] F. Paulhan: L'activité mentale, 1889, 106.
[3] E. Rabier: *Leçons de philosophie*, I., 1896, 157.
[4] J. Sully: *The Human Mind*, 1892, I., 283; *Outlines of Psychology*, 1891, 157.
[5] J. M. Baldwin: *Handbook of Psychology, Senses and Intellect*, 1890, 146-7.
[6] *Op. cit.*, 147.
[7] W. Wundt: *Outlines of Psychology*, tr. 1901, 282.
[8] O. Kuelpe: *Outlines of Psychology*, tr. 1901, 182.
[9] H. Hoeffding: *Outlines of Psychology*, tr. 1891, 130.
[10] H. Taine: *On Intelligence*, tr. 1899, I., 40.

Ladd and James discuss our subject only briefly. The former tells us that the image often lingers persistently in consciousness at a marked degree of intensity, and that images and perceptions differ mainly in their other characteristics.[1] James asserts that "the difference between the two processes feels like one of kind and not like a mere 'more' or 'less' of the same."[2] Then he adds: "The subjective difference between imagined and felt objects is less absolute than has been claimed."[3]

As a third group we must mention three writers, Stout, Jodl, and Ziehen, who hold the general view that images and sensations are *toto genere* different and therefore incomparable things. It follows as a corollary that their intensities also do not admit of comparison. Stout believes that images have intensity, but that this differs radically from the intensity that we attribute to sensations.[4] Sense experience for Stout has an aggressive character which is essential to its nature and not merely due to concomitant motor or organic sensations. The image, we are told, may be just as bright and loud as the sensations, but it lacks the element of aggressiveness which alone could make its brightness or loudness like that of a sense perception. Jodl insists that images may have all the degrees of intensity that are to be found among sensations, but because they are essentially of different composition, are made of different material, we can never compare the intensity of an image with that of a sensation. "Is a *fortissimo* that we image softer than a *fortissimo* that we hear, is sunlight that we perceive brighter than sunlight that we image, is imaged sugar less sweet than tasted sugar? Every attempt to answer this leads to absurdity."[5] Ziehen's position is more difficult to define. He regards the nature of images as such that they can have no intensity, properly speaking. "It is not a difference in *intensity* between the idea and the sensation, but above all a qualitative difference. The sensual vivacity, characteristic of every sensation, does not belong *at all* to the idea, not even in a diminished intensity."[6]

It is difficult, of course, in any grouping of writers, to avoid a certain amount of misplacement and complication, since point of view and general treatment differ widely. We find, however, as has just been shown, three types of theories regarding the intensity of images. The first takes as its watch-word the phrase, "Images are faint copies of sensation;" it regards images as identical with sensations in quality but as much less intense. The second holds that intensity may differ, but that it frequently does not; the textural difference is all-important. The third regards difference in nature as an insuperable obstacle to any comparison of the intensities of image and sensation. To abstract consideration it would appear that the first class slurs those characteristic differences which make mind the rich and interesting thing it is, and that the third class so overemphasizes these differences as to do away with that degree of unity which mind seems to possess. Whether or not the view of the second class mentioned above is tenable must be decided, however, not by *a priori* speculation but by experimental investigation alone.

(*b*) *Experimental*

Thus far there has been no experimental work especially directed to the question of the intensity of images. Mention of the subject has been made incidentally, in connection with the discussion of other problems. It will

[1] G. T. Ladd: *Psychology, Descriptive and Explanatory*, 1894, 239, 241.
[2] W. James: *The Principles of Psychology*, 1905, 70.
[3] *Op. cit.*, 72.
[4] G. F. Stout: *A Manual of Psychology*, 1899, 399.
[5] "Ist ein Fortissimo welches wir vorstellen leiser als ein Fortissimo welches wir hoeren, ist Sonnenlicht das wir sehen heller als Sonnenlicht welches wir vorstellen; vorgestellter Zucker minder süss als geschmeckter? Jeder Versuch darauf eine Antwort zu finden, fuehrt ins Absurde." F. Jodl: *Lehrbuch der Psychologie*, 1903, II., 92 f.
[6] T. Ziehen: *Introduction to Psychological Psychology*, tr. 1893, 152.

be necessary for us to glance only at the results that refer to the memory image.

Experimental investigations of memory are practically confined to the last fifteen years. Prior to this time we have only the introspective record of Galton, who remarks that a remembered object is to him quite comparable to the real object. "I feel as though I was dazzled when recalling the sun to my mental vision."[1] Other instances also are given in which the memory image appeared to be as bright as the actual scene. The investigation of mental imagery by Lay in 1898[2] rests on the questionary method, and its results ought not to be accepted without careful criticism. We find, however, a record of images of considerable intensity, though this fails to measure up to the intensity of corresponding sensation. Meakin[3] and Moore[4] worked respectively on the mutual inhibition and on the control of memory images. The former makes no mention of intensity, and Moore tells us only that an image may be vivid for a period of five minutes. More to our purpose are the experiments of Kuhlmann. In his first series, he investigated the nature of imagery in the recall of a given material; he directed his subjects to recall, after a long interval, and to draw certain meaningless visual forms.[5] Two types of images were found, the spontaneous and the slowly developing image, yet these in their completed state differed not so much in intensity as in other attributes. Kuhlmann tells us that "less intensity and vividness is among the least of the characteristics in which the memory differed from its perceptive experience."[6] In another article this author states that, in the case of the spontaneous images, "the words would ring out clear and intense" and "the imagery then approached the perceptive quality characteristic of all vivid recall."[7] In a further study, dealing with recognition, Kuhlmann says: "We have ceased to be satisfied with the conception of memory as reproduced past experience, of images as faint copies of original perception. We may regard this condition as a good index of the state of our progress."[8] Gore, in an article entitled "Image or Sensation," entirely rejects intensive difference between images and sensations. "Could you rule out the ideational or perceptual setting, your image would leave off being an image. It would become sensational in quality and value."[9] H. B. Alexander has also touched upon our problem, but gives us simply a record of personal observation during several years. He finds that "with reference to vividness, three grades of intensities are to be discriminated."[10] His description of the three classes, however, betrays a confusion between intensity and clearness. The first, fleeting images of common thinking, are described as vague, fragile, and ephemeral; the second as small and watery, but growing clearer and assuming color under attention; the images of the third class are life-sized, clear, and bright, with definite background. Memory images, he says, are often more vivid than after-images or than dim perceptions. Slaughter[11] and Murray[12] barely mention the question of intensity, both laying emphasis upon the motor and kinæsthetic elements in reproduction.

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[1] Sir F. Galton: *Inquiries into Human Faculty*, 1883, 89 f.
[2] W. Lay: *Mental Imagery*, 1898.
[3] F. Meakin: *Mutual Inhibition of Memory Images*, Harv. Psych. Studies, I, 1903, 244.
[4] C. S. Moore: *Control of the Memory Image*, Harv. Psych. Studies, I, 1903, 282.
[5] F. Kuhlmann: *Analysis of the Memory Consciousness*, Psych. Rev., XIII, 1906, 316.
[6] *Op. cit.*, 342.
[7] F. Kuhlmann: *On the Analysis of Auditory Memory Consciousness*, Amer. Jour. Psych., XX., 1909, 200.
[8] F. Kuhlmann: *Problems in Analysis of Memory Consciousness*, J. of Phil., Psych., and Sci. Meth., IV, 1907, 1.
[9] W. C. Gore: *Image or Sensation?* J. of Ph., Psy., and Sci. Meth., 1, 1904, 437-8.
[10] H. B. Alexander: *Some Observations on Visual Imagery*, Psych. Rev., XI, 1904, 320.
[11] J. W. Slaughter: *A Preliminary Study of the Behavior of Mental Images*, Amer. Jour. Psych., XIII, 1902.
[12] E. Murray: *Peripheral and Central Factors in Memory Images of Visual Forms and Color*, Amer. Jour. Psych., XVII, 1906.

The studies of the memory image made by Bentley[1] and Whipple,[2] the one dealing with vision and the other with audition, make no reference to our problem, with the exception of Whipple's statement that the image, when held, decreases rapidly in intensity. Kennedy gives a brief summary of the results thus far obtained with regard to judgments of intensity in paired memory images. "In the case of the intensity of sound we find a decrease in the intensity of the memory image; in the case of light, either a decrease or increase of the intensity of the image according to the intensity of the object itself; and in the case of squares and of pressure, a quantitative increase in the image."[3] The general light thrown upon our subject by the above investigations, then, is merely an indication that introspection reveals intensity as an attribute of images and that this intensity has various degrees. The need for further and more definite study is apparent.

Difficulties and Sources of Error

The study of imagery is subject to certain difficulties to which we ought to pay regard at the outset. One of the greatest of these, and one which occurs in the field of sensation as well, though in a less serious form, is what is technically known as the stimulus-error. It is the tendency to evaluate sensations and images in terms of the stimuli which produce them, instead of in terms of the conscious experience itself; the error of allowing a knowledge of the objective order of things to bias introspection. Unless this error is avoided, results become practically worthless. In our experiments, therefore, we have attempted in various ways to eliminate it. The two sounds whose images were to be compared were produced by the same stimulus; there was no difference in pitch or timbre, but only in intensity. Thus, there is no reason why reference to the stimulus should influence judgment. Moreover, the actual stimulus was not seen by the observers; they saw neither the force of the stroke upon the fork nor the distance of the drop of the sound-pendulum. There were cases in which one of our observers, especially, had visual images of this distance; but this fact could not be regarded as evidence of the stimulus-error, since her visual imagery was avowedly based upon actually experienced (that is, heard) intensities, and not upon a memory or perception of the distance of the swinging pendulum. The danger of the stimulus-error was further reduced by the fact that our observers were merely instructed to compare memory images, and it was this comparison, and never that of the sensations, that received emphasis throughout the entire experiment. The judgments of the observers were thus directed a step farther than sensation from the original stimulus. With these various precau-

[1] I. M. Bentley: *The Memory Imagery and its Qualitative Fidelity*, Amer. Jour. Psych., XI, 1899.
[2] G. M. Whipple: *An Analytic Study of the Memory Image and the Process of Judgment in the Discrimination of Clangs and Tones*, Amer. Jour. Psych., XII, 1900-01.
[3] F. Kennedy: *On the Experimental Investigation of Memory*, Psych. Rev., V, 1898, 493.

tions our results would seem to be practically, if not entirely, free from stimulus-error.

More serious even than the danger just mentioned is that of confusing intensity with clearness. With respect to this Wundt cautions us as follows: "We must be especially careful not to confuse the clearness of an idea with its intensity. That is simply dependent upon the sensations which constitute it. The intensity of perceptual ideas is determined by the strength of the sense stimuli, that of memorial ideas by other conditions which have nothing to do with ideational clearness. At the same time, intensity usually promotes clearness and distinctness."[1] By clearness we mean that sharpness or focal distinctness which depends upon, or is identical with, the degree of attention. "As applied to our ideas, then," says Wundt, "clearness and distinctness denote properties which depend directly upon the activity of ideation."[2] Intensity, in the psychological sense, is the strength or force of a sensation or image in consciousness.[3] It is an attribute of a sensation or image, and, if not absolutely, is at least relatively independent of the attitude of the observer, even if upon further investigation it should develop that attention affects intensity.

Before taking up our experiments, therefore, it was necessary by means of preliminary experiments so to familiarize our observers with the introspective difference between clearness and intensity that their reports should be free from any confusion of the two. In these preliminary experiments, two metronomes of different intensities were allowed to beat,and the observers were instructed to perform aloud some task, such as spelling, reciting, or adding, and to attend now to the loud, now to the weak metronome, or else to their task. After 40 seconds they dictated their introspections. The results of these experiments show that the observers were able to hold the weak metronome at a maximal clearness for most of the time, even in the face of the more intense metronome and of the task that was being performed. When the weak metronome was maximally clear, the task and the louder metronome usually alternated in the background. The experiments were then repeated, with the exception that the task was now performed in terms of mental imagery. The observer was told to attend to one of the metronomes while employing visual imagery in counting, spelling, or reciting, having auditory images of the chimes playing a familiar air, or kinæsthetic

[1] W. Wundt: *Lectures on Human and Animal Psychology*, tr. 1901, 247.
[2] *Op. cit.*, 246.
[3] See W. H. Sheldon: *Definitions of Intensity*, Jour. of Ph., Psy., and Sci. Meth., I., 1904, 233-237.

images of lifting weights. After a brief practice in this, the attention of the observers was directed to the task instead of to the metronome. With little difficulty they were able to get very clear images, while scarcely hearing at all either the loud or the weak metronome. In the next and final group of preliminary experiments only one metronome, loud or weak, was sounded, the observer performing a task aloud and getting an auditory image of the other metronome. At the beginning of each experiment the metronome to be recalled in image was sounded for an instant, and an interval was allowed to intervene before the observers' recall. That all of our observers found it possible, while performing mechanically some task, to keep clear and focal the image of a weak metronome and yet to be conscious that the real metronome beating in the background was louder than the image, goes to show that they had succeeded in sharply distinguishing intensity from clearness. Entirely of their own accord the observers gave many reports of "weak metronome clear, loud metronome vague and dim." These results, added to the fact that all of our observers were practised in introspection, seemed to warrant us in proceeding to our specific study regarding the intensity of images with the assurance that this would not be confused with clearness.

Experimental Procedure

Our experimental investigation of the problem of the intensity of images was confined to the memory image, with the exception of a few experiments involving the image of imagination.[1] The memory image has been variously defined. For us, however, the term designates that experience which does not come to us through external sense perception, yet reproduces this perception to consciousness with its specific temporal reference in such a way as to be clothed with recognition. This, then, is the image whose intensity we endeavored to investigate. The 'mental image' or general, timeless image was left entirely out of account.[2]

Four observers took part in these experiments: Dr. Helen M. Clarke (C), fellow in psychology; Dr. L. R. Geissler (G), instructor; Mr. W. S. Foster (F), assistant; and Dr. T. Okabe (O), scholar in psychology. All of these observers had had an exceptional amount of training and practice in

[1]For a discussion of the differences between images of memory and of imagination, see C. W. Perky: Amer. Jour. of Psych., XXI., 1910, 422-452.

[2]See Bentley: *The Memory Image and its Qualitative Fidelity*, Amer. Jour. of Psych., XI., 1899, 27 note; also Slaughter: *A Preliminary Study of the Behavior of Mental Images*, Amer. Jour. of Psych., XIII., 1902, 526.

introspection. Throughout the experiments they were kept in ignorance of the purpose of our investigation. They were asked merely to reproduce an experience in memory, and to write their introspections upon the event. Since these introspections were not guided by suggestions of any kind, there were numerous instances in which no mention whatever was made of intensity. The fact that many of the introspections failed to speak of intensity, therefore, does not militate in any way against our conclusions.

Our experiments fall into eight series as follows:

Series 1. The purpose here was to find out in a preliminary way whether or not the observers spoke of intensity and, if so, in what terms. The observer was seated with his back to a table three meters distant. Upon this table stood a tuning-fork on a resonance box. After giving a 'ready' signal, the experimenter struck the fork with a felt hammer and allowed it to sound for one second before damping. After an interval of half a second the fork was struck again, the stroke being either markedly louder or weaker than, or approximately equal to, the first stroke. Again the fork was allowed to sound for one second. The observer was told to wait until all memory after-images had passed, and then to reproduce the whole experience in memory. After every such experience he carefully recorded his introspections.

Series 2. In order to secure a greater uniformity of conditions, it seemed wise to control the length of the interval between the stimulus and the image, and to secure a check upon the mental operations of the observer during this time. After a number of trials with all of our observers, we decided upon 20 seconds as the shortest interval which might safely be assumed to free the observer from the effects of memory after-images. The above experiments were then repeated with the following modifications: After giving the two sounds, a 20 second interval was allowed to pass. These intervals were filled alternately by allowing the observer's attention to follow its own capricious course and by directing it into certain channels through the following means: noise, either voice or metronome; tone, either tone variator or harmonical; or vision, either colors or pictures. In this manner we attempted to avoid the danger of having the image affected by special or persistent characteristics of the experiences that might fill up the interval before recall.

Series 3. Having tried the shortest possible interval after the cessation of memory after-images, we next undertook a brief series of experiments with a decidedly longer interval, in order to see if the length of the interval had any effect upon intensity. The method of Series 2 was repeated in all details,

except that the 20 second interval was lengthened to one minute.

Series 4. Even at this point it was clear that our observers ascribed intensity to the image, and that this imaginal intensity had many different degrees. The question then arose in how far these various degrees were comparable with those of the sensational scale. In attempting the answer, we produced sensations both noticeably and just noticeably different[1] in intensity, determining in each case, of course, just what this difference should be. Some objective scale of stimulus intensities thus became necessary. Instead of the tuning-fork, therefore, we resorted to the sound-pendulum. Series of four just noticeably different strokes—on the pendulum scale, for instance, 20°, 32°, 40°, 55°—were given both ascending and descending; also a series of three strokes noticeably different—20°, 45°, 75°—in ascending and descending order; and a series of two just noticeably different strokes—for instance, 32°, 40°—ascending and descending. Each of these six stimulus series was repeated four times in all without definite or consecutive order. At the fourth or final trial of each series the stimulus was given while the observer had his memory image, in order thus to get some control or check upon the absolute intensity of the image. It seemed best in these experiments to lengthen the interval between the stimulus and the getting of memory images from 20 to 30 seconds, because of the slightly longer duration of the memory after-images in the case of the four-stroke series. From the three observers who gave their results on auditory imagery we thus obtained seventy-two introspections. G's auditory imagery having shown itself to be very meagre, the above experiments were carried out in his case with weights as stimuli instead of sounds, the procedure in all other respects being analogous to the above.

Series 5. In this series we again used noticeable and just noticeable differences, but changed the preceding conditions in the two following ways: (*a*) Only pairs of strokes were used; and (*b*) the interval preceding recall was now of various lengths—not only 30 seconds as before, but also 60 and 120 seconds. As to the direction of the observer's attention during the interval, the procedure of the former series was

[1]The 'just noticeable difference' of this paper is not the ordinary differential limen of the psychophysical methods, but a difference such as would be recognized by the observer in at least 90 of 100 consecutive trials. In other words, it is a Fechnerian just noticeable difference, the least difference that an observer can 'carry in his head,' the just noticeable difference of Ebbinghaus' first form of the method of that name. This difference was carefully determined, for each observer, at the beginning of our experiments, and was tested, less accurately, at intervals during their progress.

not changed. It should be mentioned that at various times throughout the course of this series the stimulus was repeated for the purpose of comparison with the observer's image. For observer G the stimuli were again lifted weights.

Series 6. Observations were now made on images of imagination instead of upon memory images. At the beginning of every sitting the experimenter sounded on the pendulum a stroke of moderate intensity, 40° on the scale. After this sound, five minutes were allowed to pass in general conversation, and then the observer was asked to imagine, according to the direction of the experimenter, certain pairs of strokes. These pairs were both ascending and descending in order, now noticeably different, now just noticeably different in the centre of the scale, now just noticeably at the loud end of the scale, and now just noticeably different at the weak end. The observer signalled the appearance of the image, and the experimenter immediately sounded two strokes such as the observer had been told to imagine. The latter thereupon reported how his images compared in intensity with the strokes just sounded. In the cases of a failure of correspondence, the experimenter continued giving other pairs of strokes until the observer said "My images were like those." This usually took only one or two trials—too few for the observer's image to fade in the meantime. The method, though not free from error, was accurate enough to show us the nature of just noticeable differences and noticeable differences in the image, as compared with those on the scale of sensory intensities.

Series 7. A series of experiments was now performed in order to investigate the minimal and maximal limits of imaginal intensity. Both very loud and very weak sounds were given on the gravity phonometer as well as on the sound-pendulum. After a 30 second interval, the observer was asked to reproduce the sound in image.

Series 8. In order to compare our results in the field of auditory imagery with those which might be obtained in other fields, we instituted a series of tests on brightnesses. The brightness-discrimination box was used, an apparatus which enables the observer to see simultaneously two brightnesses side by side. The brightness of both openings, or of either one singly, could be regulated at will and determined by a scale on the box.[1] The observer sat directly in front of the centre of the box in a dark room and after a period of adaptation two brightnesses, either noticeably or just noticeably different, were shown. He then waited until all after-images had dis-

[1]For a fuller description of this apparatus, see G. M. Whipple: *Manual of Mental and Physical Tests*, 1910, 163.

appeared, and recalled the experience in a memory image, dictating his introspections to the experimenter.

The results of the above experiments seemed sufficient to warrant conclusions regarding the intensity of auditory memory images, and to tell us something also regarding visual and kinesthetic memory images.

RESULTS

1. *Intensity.* (*a*) *Ascription of intensity to images*

The first part of our problem was to determine whether or not the image possessed intensity. For the answer to this question we may simply turn to the introspections that were given. As has been mentioned above, our observers were not aware of the object or purpose of the experiments,—they did not know that our concern was with intensity at all. Their very frequent references to intensity, as an attribute of images, are therefore the more significant since there was absolutely no ground for supposing that they were reporting anything other than that which introspection actually revealed to them. Only a very few of the statements regarding this subject may be quoted here. They are selected at random and may be regarded as typical.

Series 1. Observer C. "Very clear auditory images, like the sensations in pitch, intensity, and time-interval." "Purely auditory images like the sensations in intensity." "Good images like the heard tones in pitch and intensity." "Intensity of the images a little weaker than that of the sensations."

Series 3. Observer F. "I think the images are very accurate copies of the sensations both as to quality and intensity." "Good images with intensities about like that of sensations." "The images were not quite so clear as in sensation."

Series 6. Observer O. "Images just exactly like sensations in loudness. The sensations and images differ in quality so that unless there were an element common to both I could not compare them without making an arbitrary standard. I do not do this but compare them by their intensities; therefore I know that intensity is the common element, although they differ in every other way, force, liveliness, purity, etc." "Got good images but the first was a little too strong. The second was just like the sensation in intensity."

Series 4. Observer G (lifted weights). "In the image the second was distinctly more intense." "Images like the sensations in intensity."

Series 2. Observer F. "I think the images are very accurate copies of the sensations as to intensity." "Intensities of images about correct." "Loud image good and like the sensation in intensity, weak image not clear this time and a little too loud."

Thus, our observers spontaneously attributed intensity to the image, and this occurred in by far the greater number of our experiments.

The question naturally arises, in this connection, whether the images induced under experimental conditions are the

same as "the normal waking images of every-day life."[1] This query occurred to Slaughter, and he tells us that it is impossible to answer it. It is, however, merely the old question of the value of experimental introspection, recurring in special form, and as such is possible to answer. All of our observers regarded the images evoked in the laboratory as like their ordinary images, with the possible exception of G. This observer had very poor auditory images, and reported them as being so weak as almost to lack intensity altogether, although, as he said, his ordinary, normal auditory images, while they are usually vague, often have a marked degree of intensity. Such statements did not occur in the case of our other observers, nor with G in the field of kinæsthesis. It may be questioned whether the meagre auditory images which G had in the laboratory were really memory images at all, for he tells us that in numerous cases "the images involve no reference to the previous sensations; they occur as independent conscious events."

(*b*) *Varying degrees of imaginal intensity*

The following results furnish the answer, in part at least, to the second portion of our problem, the question, Can the intensities of images be compared with sensational intensities, and to what extent? The results of the different series, so far as they bear upon the varying degrees of imaginal intensity, may conveniently be thrown into the form of Tables. Con-

TABLE I

Series 1: Tuning-fork struck at two noticeably different intensities; no definite interval before recall.

Obs.	Exp'ts made	Absolute imag. int. mentioned	Imaginal = sensational intensity	Both images weaker	2nd im. weaker or stronger than first
C	33	11	9	2	
F	29	13	12	1	
O	32	18	6		12

cerning the judgments in this series (column 4) and in all following series under the rubric 'both images weaker,' it is important to mention that our observers also reported that the difference in intensity between the images was the same as the intensive difference between the sensations. Thus, C

[1] *Cf.* Slaughter: *A Preliminary Study of the Behavior of Mental Images*, Amer. Jour. Psych., XVIII., 1902, 548.

reports: "The auditory images were like the sounds in relative intensity, but both images were a little less intense than the corresponding sensations;" "both images weaker, but like the sounds in difference of intensity." The following statement of F is to the same effect: "Both images weaker than corresponding sensations . . . intensive difference between images like that between the sensations." O, indeed, gave two judgments reporting the difference in intensity as greater in image than in sensation. "The difference in loudness between the two images seemed greater than in sensation,—it seemed too great;" "the images were pure and simple and the difference in loudness seemed too great."

The experiments with G are not recorded in the Tables because his auditory imagery was, as a rule, too poor to admit of full introspective accounts. We give three of his most definite introspections: "I get no intensive difference between the images, although it was plain enough in the sensations;" "there seemed to be no difference in intensity between the images;" "the intensive difference between the two sensations was marked, but the only difference between the images is a stronger breathing accompanying the image which corresponds to the louder sensations."

TABLE II

Series 2: Fork struck at two n. d. intensities; before recall a 20 sec. interval either left for *O* to fill or filled by *E* with noise, tone, or visual stimuli.

Obs.	Exp'ts made	Absolute imag. int. mentioned	Im. = sens. intensity	One im. correct	Both im. weaker	Both different in int
C	24	12	8		4	
F	24	7	3	2		2
O	24	8	2	3	1	2

The reports of columns 5, like the corresponding reports of *Series 1*, include also the judgments that the difference in imaginal intensity was the same as that between the intensities of the sensations. Besides the above, F and O reported four and ten times respectively that the difference in the intensity of the images was the same as the difference between the sensations, without, however, making mention of absolute intensity.

Nearly all of G's images came in kinæsthetic instead of in auditory terms. As regards the direction of the observer's attention during the interval, we find that, in all but two of the cases in which the intensity of the images was like that of

the sensations, this occurred when *O*'s attention was allowed free play. The two exceptions were reported by O and occurred when the interval was filled by *E*'s reading nonsense syllables.

TABLE III

Series 3: Series 2 repeated with one minute interval before recall instead of 20 sec. interval.

Obs.	Exp'ts made	Absolute imag. int. mentioned	Imag. = sens. intensity	One im. correct	Both images weaker
C	10	5	4		1
F	10	5	3	2	
O	10	4	1	3	

C here reported two cases in which the difference between the images was like that between the sensations, but she failed to make any statement regarding their absolute intensity. There is no evidence in the results of this series that the filling of the interval affected the images, except O's statement that his images are easier to get after an 'empty' interval, *i. e.*, an interval in which attention was allowed to follow its own course. In two cases F mentions that his image seems to be a 'general' image rather than a memory image, and in his final introspection he states it as his belief that the same thing was true in a number of cases. In this series of experiments, G was able to report two cases in which imaginal intensity was like that of sensation The results of this series, it will be noticed, agree in general with those of the above series.

TABLE IV

Series 4: Sound-pendulum; six series consisting of 2 j. n. d. strokes, 4 j. n d. strokes, and 3 n. d. strokes, in ascending and descending orders. Interval of 30 sec. (filled or empty) before recall.

Obs.	Exp'ts made	Absolute imag. inten. mentioned	Imaginal = sensational intensity	Both images weaker
C	27	6	6	
F	26	8	4	4
O	25	3		3

Besides the seven cases (in column 4) in which both images were weaker but the intensive difference between them was the same as that between the sensations, C reported two

cases of correct difference without mentioning absolute intensity. There seems to be no regularity as to which series is most often reproduced correctly in image.

This set of experiments, however, brought out an interesting fact in connection with images of noticeable and just noticeable differences. F reported four cases in which a just noticeable difference was increased in image, and two in which such a difference seemed to grow even smaller; in the case of noticeable differences, three introspections tell us that the difference is lessened in the image. The following record of F's reports makes this point clear:

Stimulus 2 j. n. d. sounds. "I think that the difference between the two intensities in the image was greater than that between the two sensations;" "the difference in the intensity of the two was greater in image than in sensation;" "good auditory image of first sound with intensity like that of sensation, but the second image had greater intensity than the second sensation had." *Stimulus 4 j. n. d. sounds.* "I think the weakest image was too strong and the strongest too weak." *Stimulus 3 n. d. sounds.* "There was less difference of intensity in the series of images than in sensation;" "loudest image not loud enough and weakest too loud;" "loudest image not loud enough and weakest too strong."

Both F and C mentioned cases in which a j. n. d. was eliminated and the two sounded equal in image:

F. *Stimulus 2 j. n. d. sounds.* "Images of equal intensity;" "sounds alike in intensity in image."

C. *Stimulus 2. j. n. d. sounds.* "Auditory images of the same intensity;" "both images were equally intense."

TABLE V

Series 5. Pairs of j. n. d. and n. d. strokes; interval of 30 sec., 60 sec., or 120 sec. (filled or empty) before recall.

Obs.	Exp'ts made	Absolute imag. inten. mentioned	Imaginal = sensational intensity	Both images weaker
C	18	3	1 (n.d. 60 sec.)	2 (120 sec.) (30 sec.)
F	21	6	4 (j. n. d. 30) (j. n. d. 30) (n. d. 60 sec.) (n. d. 60 sec.)	2 (60 sec.)
O	20	4	3 (j. n. d. 30) (j. n. d. 60) (j. n. d. 120)	1 (30 sec.)

For the sake of uniformity in the Tables, we have arranged the results of this series also with reference to absolute intensity. The series was undertaken, however, primarily in order to observe the effect of different time-intervals upon the noticeable and just noticeable differences. Our results with regard to this point follow.

Just noticeable difference too great in image: C, 1 case (120 sec.); F, 2 cases (120 sec.); O, 3 cases (30 sec, 60 sec., 120 sec.). Just noticeable difference noticeable in image (images equal); C, 1 case (60 sec.); O, 2 cases (120 sec.). Noticeable difference too small in image: C, 1 case (120 sec.); F, 2 cases (120 sec.); O, 4 cases (30, 60, 120, 120 sec.). Thirty-one tests with lifted weights were made with G, with the following results: 5 mentions made of absolute intensity; 3 cases in which a just noticeable difference was too great in image (60 sec., 120 sec., 120 sec.); 8 cases in which a noticeable difference was too small in image (either 60 sec. or 120 sec.).

The fact that in many cases the just noticeable differences are greater and the noticeable differences less in the image suggests Leuba's hypothesis with regard to the intensity of the single image. "There seems to be a natural tendency in us to shift the sensations held in memory towards the middle of the scale of intensities. It might be conceived to operate somewhat as follows. The image of a recent sensation tends to recall by association the united residual of all past sensations of the same kind."[1] As far as absolute intensity goes,—and it is to this that the quotation refers,—we have found in our experiments no traces of such a tendency. Our results, however, show that at times the relative intensity or difference in intensity between two images does seem to approach a mean, the just noticeable differences increasing, and the noticeable differences decreasing, in imagery. A closer study of our results shows that this change occurred almost entirely after the long intervals. Thus we can regard it as one of the effects of time upon the two images, rather than as a general characteristic of all pairs of images. F reported that after the longer intervals he was conscious of getting not a real memory image but a sort of 'general' image, referring to no sensations in particular. His reports in the case of the one minute interval of Series 3 are in harmony with his observation in this series. From his introspections we gather that this 'general' image, probably the 'mental image' of psychologists, is usually of moderate intensity. We quote one report: "Relaxation at the tone which was of moderate intensity. I reproduced a 'general' experience and not the particular one this time. I feel that this is what I have been doing usually after the long interval."

Leuba's reference to the "residual of all past sensations" indicates that he refers to this timeless mental image and not to the specific memory image. We must not, however, be understood to mean that in every case in which our observers had an increase in image of what was a small intensive difference for sensation, or a decrease in image of the intensive difference of a markedly large sensory step, they did not get memory images at all. In a number of such cases the introspections

[1] J. H. Leuba: *A New Instrument for Weber's Law*, Amer. Jour. Psych., V., 1892-93, 382 f.

tell us that the one of the images was like the sensation in intensity, while the other was either too weak or too strong as the case might be; and this change in the one of the images may be accounted for in numerous ways. We regard as 'general' or 'mental' images only those few in which the difference in intensity was changed by the weakening or strengthening of *both* the images, and the images were thus brought to a moderate or medium degree of intensity. For our observers, such images occurred relatively frequently when there was an interval of one minute or more between the giving of the sensation and its recall in image.

Series 6: Moderate stroke given; pause of five minutes; imaginary images called up by *O* according to *E*'s directions, either j. n. d. or n. d., ascending or descending, on loud, weak, or medium part of scale.

A Table here would only complicate matters, since we are dealing with images of imagination, and also since the matter of absolute intensity is a side-issue, the important thing being the noticeable or just noticeable differences. We found, however, that in numerous cases the observer's pair of images corresponded exactly with the first pair of strokes later given by the experimenter. Of these cases O reports four; F, six; and C, six; with O the cases occurred with just noticeable differences on the strong end of the scale; with F and C they occurred with weak just noticeable differences, and a few with noticeable differences. The introspections of our observers corroborate the results which we tabulated in the course of the series. O tells us: "It is much harder to get just noticeable differences when both are weak;" "easiest to imagine strong just noticeable differences." C: "Weak images are more likely to be like the sounds than the strong ones are;" "very hard and unpleasant to try to get strong images." F: "Weak images are easier to get."

Further results regarding noticeable and just noticeable differences are as follows: Out of sixteen tests, O reported six cases in which that which he supposed to be a just noticeable difference in his imaginative image proved, on comparison with a just noticeable difference between sensations, to be greater than this. Out of twelve tests, observer F reported 1 case in which an imagined just noticeable difference proved to be too great, and three cases where an imagined noticeable difference proved to be too small, when compared with the corresponding differences in sensation. Out of twenty tests, C reported four cases of just noticeable difference too great, and two of noticeable difference too small, in the image of imagination. This seems to indicate that, while we can image in imagination both large and small intensive differences, there is a slight tendency for these differences to approach a type or

mean. In so far, then, their behavior resembles that of the 'mental image' mentioned above.

This result leads us to a series of experiments concerned with the limits of the intensive scale in imagery.

Series 7: Loud or weak sounds given on sound-pendulum or gravity phonometer; *O* told to reproduce in imagery.

The results here merely show that for observers C and O there were apparently no limits to the intensive scale of images. There was no sensation, however weak or strong, of which they were not able to get an adequately intensive memory image. A few of the introspections follow.

O. *Fall of 1 meter on phonometer.* "Intensity in the image, taken by itself, could not be distinguished from that of the stimulus,—the only difference was in thinness."

4° *on sound-pendulum.* "Good image just like sensation in loudness."

C. *One meter on phonometer.* "Image thin with less body than sensation, but intensity just the same."

80° *on sound-pendulum..* "Got good image just like it." Stimulus was repeated and C said, "yes, my image was just as intense as that sound."

4° *on sound-pendulum.* "Image just like that in intensity."

F could get very weak images, but he was unable to call to mind any that were louder than a fall of 75° on the pendulum or 85 cm. on the phonometer.

TABLE VI

Series 8: Pairs of brightnesses; recall in imagery.

Obs.	Exp'ts made	Absolute intensity mentioned	Im. = sens. intensity	Im. of dark stimulus too light	Im. of light stimulus too dark	Both im. too dark
C	23	19	18	1		
F	22	13	6		3	4
O	11	3	2	1		

There were two cases for each observer in which absolute intensity was not mentioned, but the difference in intensity between the images was reported as being like that between the sensations. There were also five cases for O and one for F where a small difference was imaged as greater, and one for O and four for F where a large difference was imaged as smaller than in sensation. C is of a markedly visual type, which fact probably accounts for the large proportion of her accurate images. In the field of vision, then, our results parallel those obtained in audition and kinæsthesis.

2. *Non-intensive Differences between Sensation and Image*

In the comparison of images with sensations, several facts of interest were brought out besides those immediately con-

nected with our main problem. The results above described with reference to intensity show, as we have seen, that it is not here that the distinguishing mark between images and sensations is to be found. For our observers, as we shall see, this difference lay in other characters of the two experiences. They all repeatedly emphasized the incompleteness[1] of the image as compared with sensation and found here the main point of differentiation. Indirectly, then, we find in these statements a verification of our conclusions.

The introspections regarding this point are so numerous that only a few can here be given. They are chosen at random from all the series.

F. "The images seem finer, less bulky and thick than the actual sounds;" "the tones are as intense in image as in sensation but they lack 'volume,' that is, concomitant muscular and organic sensations;" "the images are abbreviated in some way,—they lack a fullness, vividness, aliveness, sharpness, which the sensations have;" "usually concomitants such as sharp clang or aftertone and organic sensations are not reproduced in imagery;" "hard to say how the images differed from the sensations, but I know they lack certain qualities partly of sound and also perhaps of organic and muscular strains and attitudinal setting. 'Deadness' of sound is partly lack of certain qualities, especially certain higher pitches;" "the visual image is thin and threadlike as compared with the sensations. Images are very instable and the main difference between them and sensation is the fact that they are so abbreviated."

O. "Good images of correct intensity. With the sensations there are kinæsthetic accompainments which are not present in the image;" "the sensation is fuller and has an element of impressiveness that the image lacks"; "the sensations are accompanied by kinæsthetic sensations and also by noises and overtones, but none of these occur in the image, which was purer and more simple than the sensation;" "images differ from sensations not in intensity but in fullness and kinaesthetic sensations accompanying them;" "the only element common to image and sensation is intensity, they differ in every other way."

C. "Image less steady and impressive than sensation;" "got two images exactly like the sensations in intensity, but they were more subjective and did not give the kinæsthetic shock that accompanied the stimuli;" "images thin and abbreviated but like the stimuli in intensity."

G. "The images differed from the sensations mostly in their accompanying kinæsthetic sensations;" "I do not know what the difference between image and sensation is, or how I can tell which is which. The image has a sort of 'Verschwommenheit,' is thin, diffuse, vaporous, and not as clear-cut as the sensation. The difference is less a matter of degree than of quality;" "images are pure and there are no accompanying strains. The concomitants such as pressure and strains are not reproduced in image,—the images are isolated."

These and many other similar introspections made by four observers, differing widely in imaginal type, indicate that the difference between sensation and image is not one of intensity.

[1] *Cf.* Kuhlmann: *On the Analysis of Auditory Memory Consciousness*, Amer. Jour. Psych., XX., 1909, 214; E. Murray: *Peripheral and Central Factors in Memory Images of Visual Form and Color*, Amer. Jour. Psych., XVII., 1906, 231.

Another point upon which our introspections throw some light is the time-relation in imagery. In by far the greater number of introspections we find mention of the fact that the time-relations of images exactly correspond to those of sensations. There were, indeed, a few cases in which each individual image lasted too long and the interval between them was too short, and, conversely, a few in which the time interval was appreciably lengthened. The latter, however, occurred in the cases in which there was a long interval before recall and in which, as is stated above, the images partook of the nature of 'mental' rather than of memory images. On the basis of our results, therefore, we are able to say that memory images tend, in introspection, to reproduce exactly the time-relations of the original sensational experience. The images, moreover, always tended to become less accurate, both as to intensity and as to temporal relation, when there were a number of repetitions of the recall of the original sensation.

Of the many minor facts brought out by our experiments we should, perhaps, mention also the important rôle that kinæsthesis plays in imagery. Others who have investigated auditory imagery have noticed this same fact. Kuhlmann, for example, tells us that in many cases "only one-fourth or one-half of the sound was imaged in auditory terms."[1] While our observers, as already stated, differentiated images from sensations by the lack of certain kinæsthetic elements, nevertheless, in their descriptions of imagery, they reported the presence of other kinæsthetic elements which were lacking in sensation. They found all manner of throat strains and organic attitudes that aided correct reproduction and carried much of the 'meaning' of the image. The shock produced by a stroke was not accompanied in the imagery by those starts and strains characteristic of the sensation, but other bodily tensions and kinæsthetic elements were substituted for them, and gave meaning to the memory image. While pitch was usually recalled in auditory terms, it was sometimes carried in the memory images by throat settings of which there was no trace in the sensation. Thus, corroborating the results of Kuhlmann, our observers also reproduced the sound only partially in auditory terms. In this fact there is a further distinguishing mark of images, but a mark which, again, is not intensive.

Conclusion

The results of our experiments, then, as above described, warrant the drawing of certain conclusions concerning the

[1]Kuhlmann: *On the Analysis of Auditory Memory Consciousness*, Amer. Jour. Psych., XX., 1909, 214.

intensity of images. Our problem included the questions whether intensity is an attribute of images and, if so, whether there is a scale of imaginal intensity, and what the nature of such a possible scale may be. The answer to the first of these questions we have found in the introspections of our observers. It appears beyond doubt that, at least under ordinary laboratory conditions, images possess the attribute of intensity. It is undoubtedly true that, oftentimes, the image is to some extent weaker than the original sensation, but it is far from true that this is always or necessarily the case. The true memory image frequently reproduces very exactly the sensational intensity, be it weak or strong; the intensity of the image of imagination, though likely to be of a moderate degree, may at times be very strong as well as very weak. The 'general' or 'mental' image, being a type-image referring not to any particular sensation but to a number of past sensations of varying degrees, is almost always of medium intensity.

The question regarding the nature of imaginal intensity cannot be so briefly or so definitely answered. We have every reason to believe that there are not two different kinds of intensities, but that the intensive attribute is one and the same whether it be that of sensation or of the image. In no case did any of our observers note any difference in the nature of imaginal and sensational intensities. But we need not rely on negative evidence alone, for, as above quoted, there were introspections which stated that intensity is the one element common to image and sensation. The question that has at times been raised, "Could imaginal intensity, as such, replace sensational intensity?" we are, therefore, inclined to answer in the affirmative. One observer explicity stated that imaginal intensity, taken by itself, is the same thing as sensational intensity. Certain it is that none of our observers found any difficulty in comparing the intensities of images and sensations.

As regards, more specifically, the scale of intensities, we find that with the possible exception of the very loud end of the scale the degrees of imaginal intensity correspond with those of sensational intensity. About very weak sounds there is no doubt, and it is certain, too, that some intense sounds can be exactly reproduced in memory imagery. Whether, however, we can thus image the loudest possible sound, or the brightest possible light, or the heaviest possible weight, we have not ascertained. With this exception all manner of intensive differences, even those just noticeable in sensation, we have found to be accurately reproduced in memory; indeed, with the exception of very loud sounds in the case of observer F, no degree of intensity was given to our observers that was not correctly reproduced by them. From this it would

appear that the intensive scales of sensations and images are identical.

Incidental to the negative conclusion that the difference between images and sensations is not one of intensity, we have gained positive introspections as to the nature of this difference. Our observers regarded the incompleteness, thinness, abbreviatedness of the image as its main point of differentiation from sensation. Compared with the latter, the image lacks a certain 'aliveness' or kinæsthetic complex, and it is this which makes of it a very different thing. In so far, our results confirm the views entertained by the second group of writers to whom we referred in our historical note,—those, namely, who regard imaginal as quite comparable with sensational intensity, but maintain that the image differs from sensation in texture or nature.

We ought perhaps also to refer briefly to two other points: the influence of individual differences in imaginal type, and the question of physiological substrate. As regards the former we may remark that observer C, markedly visual in type, had more good and accurately intensive visual images than any of the other observers; G had almost no images except those of kinæsthesis, and we find him hesitant about intensity until he is tested with kinæsthetic images; the other two observers, individuals of mixed type, seemed to get all images with equal ease. As regards physiological substrate, the question arises what relation we must assume to exist between the cortical centres of sensation and memory, such that a correspondence in intensity may be rendered intelligible.

While our experiments point to certain positive conclusions regarding imaginal intensity, we are well aware that, owing to their limited scope and to the small number of our observers, we are not justified in assuming a dogmatic attitude. The intensity of images still remains a promising field for experimental investigation, an especially interesting problem being that of the upper limit of the intensive scale. In such an investigation the stimulus-error would assume large proportions; yet it might be overcome, we believe, by suitable apparatus and by a method similar to that which we have employed.